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# मानक

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IS 3688 (1990): Power transmission - Shafts - Dimensions for cylindrical and 1/10 conical shaft ends [PGD 31: Bolts, Nuts and Fasteners Accessories]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”



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*Indian Standard*

**POWER TRANSMISSION — SHAFTS —  
DIMENSIONS FOR CYLINDRICAL  
AND 1/10 CONICAL SHAFT ENDS**

*( Second Revision )*

भारतीय मानक

पावर प्रेषण — शैफ्ट — बेलनाकार और १/१० शंकवाकार शैफ्ट सिरों के आयाम  
( दूसरा पुनरीक्षण )

UDC 621.824.2

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**BUREAU OF INDIAN STANDARDS**  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

## Indian Standard

# POWER TRANSMISSION — SHAFTS — DIMENSIONS FOR CYLINDRICAL AND 1/10 CONICAL SHAFT ENDS

( *Second Revision* )

### NATIONAL FOREWORD

This Indian Standard (Second Revision) which is identical with ISO/R 775 : 1969 'Cylindrical and 1/10 conical shaft ends', issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Transmission Devices Sectional Committee (LMD 10) and approval of the Light Mechanical Engineering Division Council. This standard was first published in 1966. It was revised in 1977 taking assistance from ISO/R 775 : 1969. This second revision has now been fully aligned with ISO/R 775 : 1969.

The text of the ISO standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.
- Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

### CROSS REFERENCES

In this Indian Standard, the following International Standards are referred to. Read in their respective places the following:

<i>International Standard</i>	<i>Indian Standard</i>	<i>Degree of Correspondence</i>
ISO 286/1 : 1988* ISO system of limits and fits — Part 1 : Bases of tolerances, deviations and fits	IS 919 (Part 1) : 1963 Recommendations for limits and fits for engineering : Part 1 General engineering	Technically equivalent
ISO 286/2 : 1988* ISO system of limits and fits — Part 2 : Tables of standard tolerance grades and limit deviations for holes and shafts		
ISO/R 773 : 1969 Rectangular or square parallel keys and their corresponding keyways	IS 2048 : 1983 Parallel keys and keyways ( <i>second revision</i> )	Technically equivalent
ISO/R 774 : 1969 Taper keys and their corresponding keyways with or without gib head	IS 2292 : 1974 Taper keys and keyways ( <i>first revision</i> )	Technically equivalent
ISO 3912 : 1977* Woodruff keys and their corresponding keyways	IS 2294 : 1986 Woodruff keys and keyways ( <i>second revision</i> )	Technically equivalent
ISO 3 : 1973* Preferred numbers — Series of preferred numbers	IS 1076 (Part 1) : 1985 Preferred numbers : Part 1 Series of preferred numbers	Identical

An Erratum issued by the ISO in March 1969 relating to a value given in table on page 9 has been incorporated while printing this Indian Standard.

Addendum 1 issued by the ISO in November 1974 has been reproduced in full at the end.

\*Revision of earlier version.

## 1. SCOPE

This ISO Recommendation determines the dimensional characteristics of

- cylindrical shaft ends (long series and short series);
- 1/10 conical shaft ends (long series and short series), without keys and keyways or with keyways for parallel keys.

For cylindrical shaft ends, the transmissible torques for various applications (pure torque, torque and bending moment) are also given.

This ISO Recommendation will be completed later by details of

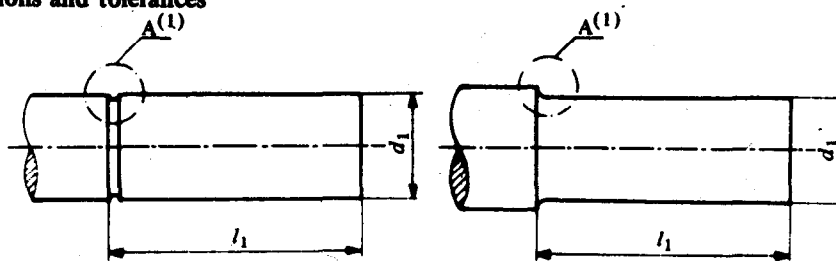
- the joining fillets for cylindrical shaft ends,
- the external and internal threads for conical shaft ends,
- the tolerances on form and position,

and by the addition of

- cylindrical shaft ends with internal thread,
- 1/10 conical shaft ends with Woodruff keys,
- conical shaft ends without keyways.

## CYLINDRICAL SHAFT ENDS

### 2.1 Dimensions and tolerances



Dimensions in millimetres

Diameter $d_1$		Length $l_1$	
nominal	tolerance <sup>(2)</sup>	long series	short series
6 7	j6	16	—
8 9	j6	20	—
10 11	j6	23	20 <sup>(3)</sup>
12 14	j6	30	25 <sup>(3)</sup>
16 18 19	j6	40	28
20 22 24	j6	50	36
25 28	j6	60	42
30 32 35 38	j6	80	58
	k6		
40 42 45 48 50 55 56	k6	110	82
	m6		
60 63 65 70 71 75	m6	140	105
80 85 90 95	m6	170	130

Diameter $d_1$		Length $l_1$	
nominal	tolerance <sup>(2)</sup>	long series	short series
100	m6	210	165
110			
120			
125			
130		250	200
140			
150			
160		300	240
170			
180			
190		350	280
200			
220			
240		410	330
250			
260			
280		470	380
300			
320			
340		550	450
360			
380			
400		650	540
420			
440			
450			
460			
480			
500			
530		800	680
560			
600			
630			

**Keys and keyways.** The order relating to the keys and keyways, if required, should specify keys and keyways in conformity with one of the following ISO Recommendations :

ISO Recommendation R 773, *Rectangular or square parallel keys and their corresponding keyways (Dimensions in millimetres);*

ISO Recommendation R 774, *Taper keys and their corresponding keyways with or without gib head (Dimensions in millimetres);*

ISO Recommendation R . . . ,<sup>(4)</sup> *Woodruff keys and their corresponding keyways.*

NOTE. — Tolerances on form and position will be specified later.

- (1) Detail A will be specified later.
- (2) See ISO Recommendation R 286, *ISO System of limits and fits — Part 1 : General, tolerances and deviations.*
- (3) The dimensions thus indicated are not in agreement with the related dimensions of the long series conical shaft ends of the table in clause 3.1.1, and attention is drawn to this deviation from the relationship stated in the Annex.
- (4) At present at the stage of draft proposal.

## 2.2 Transmissible torques

Transmissible torque in kilogramme-force metres

Shaft end diameter  $d_1$ mm	Transmissible torque			Shaft end diameter  $d_1$ mm	Transmissible torque		
	$T$ kgf.m				$T$ kgf.m		
	(a)	(b)	(c)		(a)	(b)	(c)
6		0.0315	0.015	90	580	412	195
7		0.0545	0.025	95	670	500	236
8		0.0875	0.04	100	775	600	280
9		0.132	0.0615	110	1 030	850	387
10		0.19	0.09	120	1 360	1 120	530
11		0.265	0.122	125	1 550	1 320	615
12		0.355	0.17	130	1 700	1 500	
14		0.615	0.29	140	2 120	1 950	
16		0.975	0.462	150	2 650	2 500	
18		1.5	0.69	160	3 250	3 070	
19		1.8	0.85	170	3 870	3 870	
20		2.12	1	180	4 620		
22		3	1.4	190	5 300		
24		4.12	1.9	200	6 300		
25		4.75	2.18	220	8 250		
28		6.9	3.25	240	10 900		
30	21.2	9	4.12	250	12 200		
32	25.8	11.2	5.15	260	13 600		
35	33.5	15	7.1	280	17 000		
38	42.5	20	9.5	300	21 200		
40	50	24.3	11.2	320	25 800		
42	58	29	13.2	340	30 700		
45	71	36.5	17	360	36 500		
48	87.5	46.2	21.2	380	42 500		
50	97.5	53	25	400	50 000		
55	128	75	34.5	420	58 000		
56	136	80	36.5	440	67 000		
60	170	100	47.5	450	71 000		
63	195	118	56	460	75 000		
65	212	132	61.5	480	87 500		
70	272	175	80	500	97 500		
71	280	180	85	530	115 000		
75	335	218	103	560	136 000		
80	400	272	128	600	170 000		
85	487	335	160	630	195 000		

Transmissible torque in newton metres

Shaft end dia- meter  $d_1$ mm	Transmissible torque			Shaft end dia- meter  $d_1$ mm	Transmissible torque		
	$T$ N·m				$T$ N·m		
	(a)	(b)	(c)		(a)	(b)	(c)
6		0.307	0.145	90	5 600	4 120	1 900
7		0.53	0.25	95	6 500	4 870	2 300
8		0.85	0.4	100	7 750	5 800	2 720
9		1.28	0.6	110	10 300	8 250	3 870
10		1.85	0.875	120	13 200	11 200	5 150
11		2.58	1.22	125	15 000	12 800	6 000
12		3.55	1.65	130	17 000	14 500	
14		6	2.8	140	21 200	19 000	
16		9.75	4.5	150	25 800	24 300	
18		14.5	6.7	160	31 500	30 700	
19		17.5	8.25	170	37 500	37 500	
20		21.2	9.75	180	45 000		
22		29	13.6	190	53 000		
24		40	18.5	200	61 500		
25		46.2	21.2	220	82 500		
28		69	31.5	240	106 000		
30	206	87.5	40	250	118 000		
32	250	109	50	260	136 000		
35	325	150	69	280	170 000		
38	425	200	92.5	300	206 000		
40	487	236	112	320	250 000		
42	560	280	132	340	300 000		
45	710	355	170	360	355 000		
48	850	450	212	380	425 000		
50	950	515	243	400	487 000		
55	1 280	730	345	420	560 000		
56	1 360	775	355	440	650 000		
60	1 650	975	462	450	690 000		
63	1 900	1 150	545	460	750 000		
65	2 120	1 280	600	480	850 000		
70	2 650	1 700	800	500	950 000		
71	2 720	1 800	825	530	1 150 000		
75	3 250	2 120	1 000	560	1 360 000		
80	3 870	2 650	1 250	600	1 650 000		
85	4 750	3 350	1 550	630	1 900 000		

The values of transmissible torques have been calculated from the following formulae and rounded off to normal numbers of the exceptional R 80 series <sup>(1)</sup> :

(a) *transmission of pure torque :*

$$T = \frac{\pi}{4} \times 10^{-3} \times d_1^3 \text{ (kgf}\cdot\text{m)} \quad \text{or} \quad \frac{9.80665 \pi}{4} \times 10^{-3} \times d_1^3 \text{ (N}\cdot\text{m)}$$

This torque corresponds to a stress of 4 kgf/mm<sup>2</sup>. In case of reversal of rotation fluctuations, of high or irregular torque, or of high bending and deformation moments in the coupling, the stresses will have to be checked by appropriate means.

(b) *transmission of torque and bending moment both of a known size :*

$$T = 6 \times 10^{-5} \times d_1^{3.5} \text{ (kgf}\cdot\text{m)} \quad \text{or} \quad 58.8399 \times 10^{-5} \times d_1^{3.5} \text{ (N}\cdot\text{m)}$$

This formula may be applied subject to checking when the torque and bending moment are disproportionate in their influence.

(c) *transmission both of a known torque and of an undetermined bending moment :*

$$T = 2.8 \times 10^{-5} \times d_1^{3.5} \text{ (kgf}\cdot\text{m)} \quad \text{or} \quad 27.45862 \times 10^{-5} \times d_1^{3.5} \text{ (N}\cdot\text{m)}$$

This formula is applicable to the dimensioning of shaft ends of primary machines (for example, electric motors, pumps, etc.) of general manufacture and capable of meeting all conditions of usage.

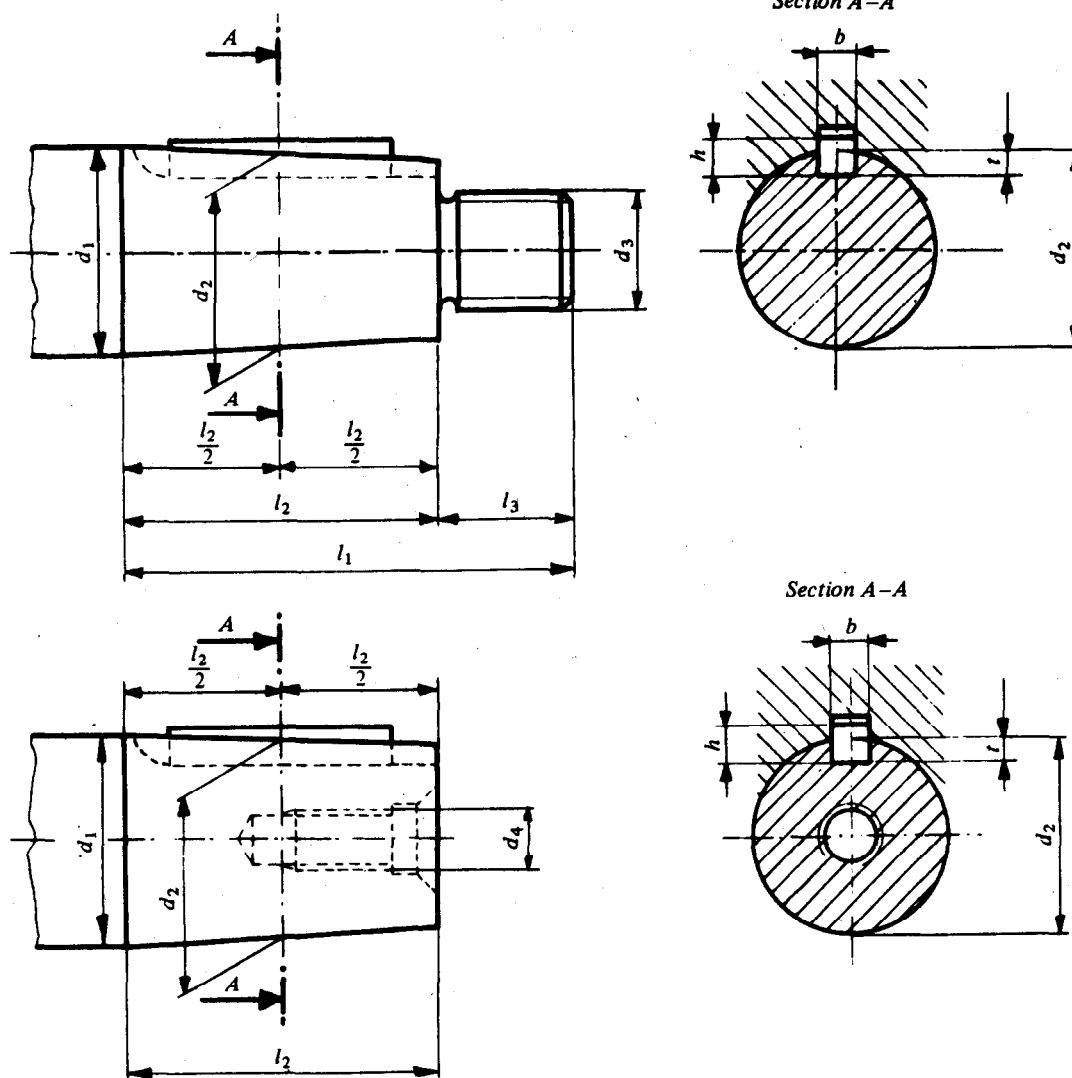
NOTE. — The three formulae assume the use of steel having a tensile strength of 50 to 60 kgf/mm<sup>2</sup>.

(1) See ISO Recommendation R 3, *Preferred numbers — Series of preferred numbers*.

### 3. 1/10 CONICAL SHAFT ENDS

#### 3.1 Long series

##### 3.1.1 Diameters $\leq 220$ mm



*Keys and keyways<sup>(1)</sup>. The keys and keyways should conform to ISO Recommendation R 773, Rectangular or square parallel keys and their corresponding keyways (Dimensions in millimetres).*

(1) 1/10 conical shaft ends can also be made without key and keyway.

1/10 conical shaft ends with Woodruff keys will be the subject of a later ISO Recommendation.

Dimensions in millimetres

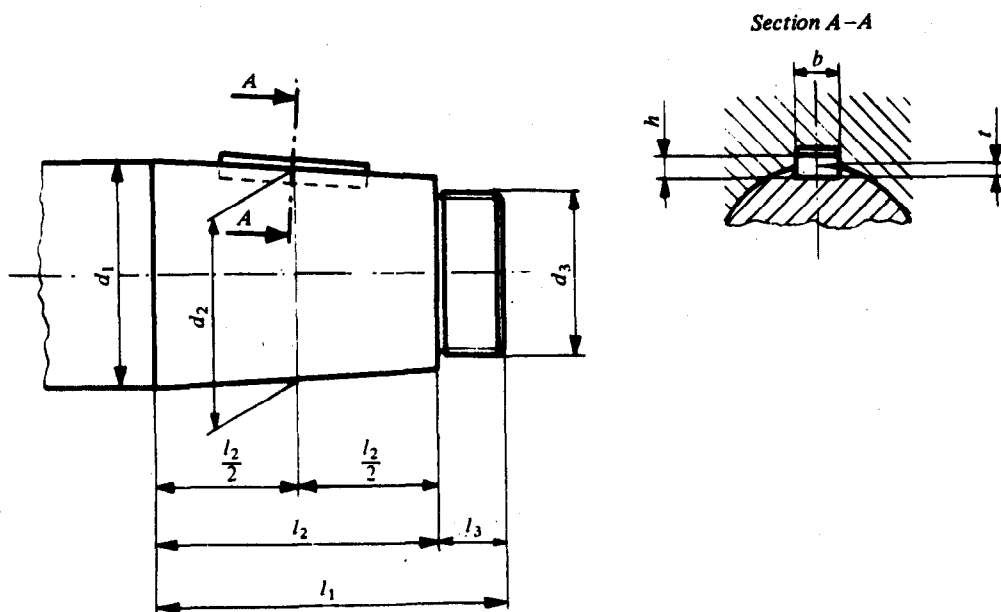
Dia- meter	Length			Key and keyway			External thread	Internal thread (1)
	$d_1$	$l_1$	$l_2$	$l_3$	$d_2$	$b \times h$	$t$	$d_3$
6	16	10	6	5.5	—	—	M4	—
7				6.5			M4	
8	20	12	8	7.4	—	—	M6	—
9				8.4			M6	
10	23	15 <sup>(2)</sup>	8	9.25	—	—	M6	—
11				10.25			M6	
12	30	18 <sup>(2)</sup>	12	11.1	2X2	1.2	M8X1	M4
14				13.1			M8X1	M4
16	40	28	12	14.6	3X3	1.8	M10X1.25	M4
18				16.6	4X4	2.5	M10X1.25	M5
19				17.6	4X4	2.5	M10X1.25	M5
20	50	36	14	18.2	4X4	2.5	M12X1.25	M6
22				20.2	4X4	2.5	M12X1.25	M6
24				22.2	5X5	3	M12X1.25	M6
25	60	42	18	22.9	5X5	3	M16X1.5	M8
28				25.9	5X5	3	M16X1.5	M8
30	80	58	22	27.1	5X5	3	M20X1.5	M10
32				29.1	6X6	3.5	M20X1.5	M10
35				32.1	6X6	3.5	M20X1.5	M10
38				35.1	6X6	3.5	M24X2	M12
40	110	82	28	35.9	10X8	5	M24X2	M12
42				37.9	10X8	5	M24X2	M12
45				40.9	12X8	5	M30X2	M16
48				43.9	12X8	5	M30X2	M16
50				45.9	12X8	5	M36X3	M16
55				50.9	14X9	5.5	M36X3	M20
56				51.9	14X9	5.5	M36X3	M20

(1) Details of the internal thread will be specified later.

(2) See corresponding shaft diameters in the table in clause 2.1, and footnote <sup>(3)</sup> to that table.

Dia- meter	Length			Key and keyway			External thread	Internal thread (1)
	$d_1$	$l_1$	$l_2$	$l_3$	$d_2$	$b \times h$	$t$	$d_3$
60	140	105	35	54.75	16X10	6	M42X3	M20
63				57.75	16X10	6	M42X3	M20
65				59.75	16X10	6	M42X3	M20
70				64.75	18X11	7	M48X3	M24
71				65.75	18X11	7	M48X3	M24
75				69.75	18X11	7	M48X3	M24
80	170	130	40	73.5	20X12	7.5	M56X4	M30
85				78.5	20X12	7.5	M56X4	M30
90				83.5	22X14	9	M64X4	M30
95				88.5	22X14	9	M64X4	M36
100				91.75	25X14	9	M72X4	M36
110	210	165	45	101.75	25X14	9	M80X4	M42
120				111.75	28X16	10	M90X4	M42
125				116.75	28X16	10	M90X4	M48
130				120	28X16	10	M100X4	—
140	250	200	50	130	32X18	11	M100X4	—
150				140	32X18	11	M110X4	—
160				148	36X20	12	M125X4	—
170	300	240	60	158	36X20	12	M125X4	—
180				168	40X22	13	M140X6	—
190				176	40X22	13	M140X6	—
200	350	280	70	186	40X22	13	M160X6	—
220				206	45X25	15	M160X6	—

3.1.2 Diameters  $> 220$  mm



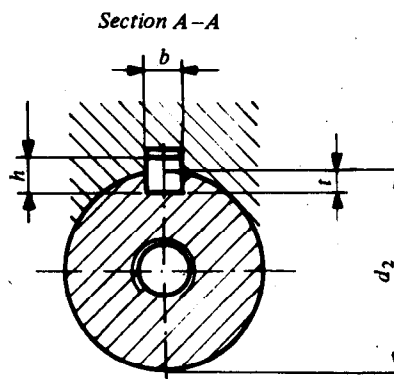
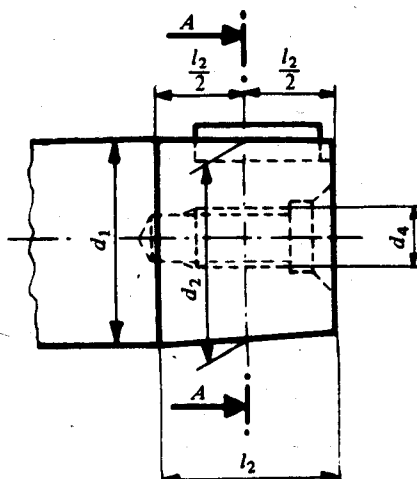
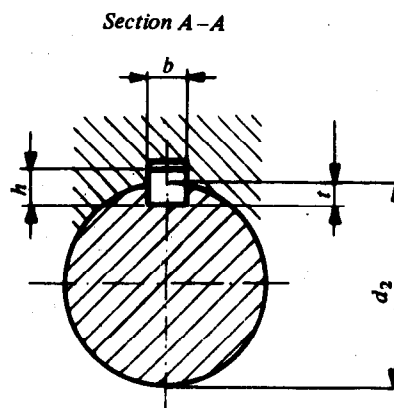
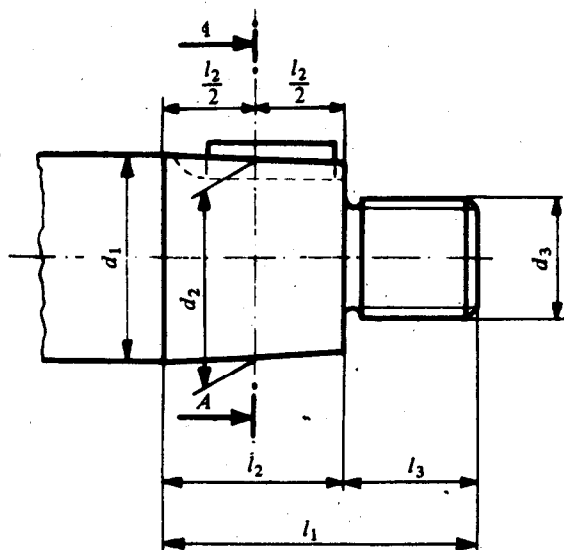
**Keys and keyways<sup>(1)</sup>.** The keys and keyways should conform to ISO Recommendation R 773, Rectangular or square parallel keys and their corresponding keyways (Dimensions in millimetres).

<sup>(1)</sup> 1/10 conical shaft ends can also be made without key and keyway.

Dimensions in millimetres

Diameter $d_1$	Length			Key and keyway			External thread $d_3$
	$l_1$	$l_2$	$l_3$	$d_2$	$b \times h$	$t$	
240	410	330	80	223.5	50 × 28	17	M180 × 6
250				233.5	50 × 28	17	M180 × 6
260				243.5	50 × 28	17	M200 × 6
280	470	380	90	261	56 × 32	20	M220 × 6
300				281	63 × 32	20	M220 × 6
320				301	63 × 32	20	M250 × 6
340	550	450	100	317.5	70 × 36	22	M280 × 6
360				337.5	70 × 36	22	M280 × 6
380				357.5	70 × 36	22	M300 × 6
400	650	540	110	373	80 × 40	25	M320 × 6
420				393	80 × 40	25	M320 × 6
440				413	80 × 40	25	M350 × 6
450				423	90 × 45	28	M350 × 6
460				433	90 × 45	28	M380 × 6
480				453	90 × 45	28	M380 × 6
500				473	90 × 45	28	M420 × 6
530	800	680	120	496	100 × 50	31	M420 × 6
560				526	100 × 50	31	M450 × 6
600				566	100 × 50	31	M500 × 6
630				596	100 × 50	31	M550 × 6

### 3.2 Short series



*Keys and keyways<sup>(1)</sup>. The keys and keyways should conform to ISO Recommendation R 773, Rectangular or square parallel keys and their corresponding keyways (Dimensions in millimetres).*

<sup>(1)</sup> 1/10 conical shaft ends can also be made without key and keyway.

Dimensions in millimetres

Diameter $d_1$	Length			Key and keyway			External thread $d_3$	Internal thread <sup>(1)</sup> $d_4$
	$l_1$	$l_2$	$l_3$	$d_2$	$b \times h$	$t$		
16 18 19	28	16	12	15.2 17.2 18.2	3 × 3 4 × 4 4 × 4	1.8 2.5 2.5	M10 × 1.25 M10 × 1.25 M10 × 1.25	M4 M5 M5
20 22 24				18.9 20.9 22.9	4 × 4 4 × 4 5 × 5	2.5 2.5 3	M12 × 1.25 M12 × 1.25 M12 × 1.25	M6 M6 M6
25 28				23.8 26.8	5 × 5 5 × 5	3 3	M16 × 1.5 M16 × 1.5	M8 M8
30 32 35 38	58	36	22	28.2 30.2 33.2 36.2	5 × 5 6 × 6 6 × 6 6 × 6	3 3.5 3.5 3.5	M20 × 1.5 M20 × 1.5 M20 × 1.5 M24 × 2	M10 M10 M10 M12
40 42 45 48 50 55 56				37.3 39.3 42.3 45.3 47.3 52.3 53.3	10 × 8 10 × 8 12 × 8 12 × 8 12 × 8 14 × 9 14 × 9	5 5 5 5 5 5.5 5.5	M24 × 2 M24 × 2 M30 × 2 M30 × 2 M36 × 3 M36 × 3 M36 × 3	M12 M12 M16 M16 M16 M20 M20
60 63 65 70 71 75	105	70	35	56.5 59.5 61.5 66.5 67.5 71.5	16 × 10 16 × 10 16 × 10 18 × 11 18 × 11 18 × 11	6 6 6 7 7 7	M42 × 3 M42 × 3 M42 × 3 M48 × 3 M48 × 3 M48 × 3	M20 M20 M20 M24 M24 M24
80 85 90 95				75.5 80.5 85.5 90.5	20 × 12 20 × 12 22 × 14 22 × 14	7.5 7.5 9 9	M56 × 4 M56 × 4 M64 × 4 M64 × 4	M30 M30 M30 M36
100 110 120 125				94 104 114 119	25 × 14 25 × 14 28 × 16 28 × 16	9 9 10 10	M72 × 4 M80 × 4 M90 × 4 M90 × 4	M36 M42 M42 M48
130 140 150				122.5 132.5 142.5	28 × 16 32 × 18 32 × 18	10 11 11	M100 × 4 M100 × 4 M110 × 4	— — —
160 170 180				151 161 171	36 × 20 36 × 20 40 × 22	12 12 13	M125 × 4 M125 × 4 M140 × 6	— — —
190 200 220				179.5 189.5 209.5	40 × 22 40 × 22 45 × 25	13 13 15	M140 × 6 M160 × 6 M160 × 6	— — —

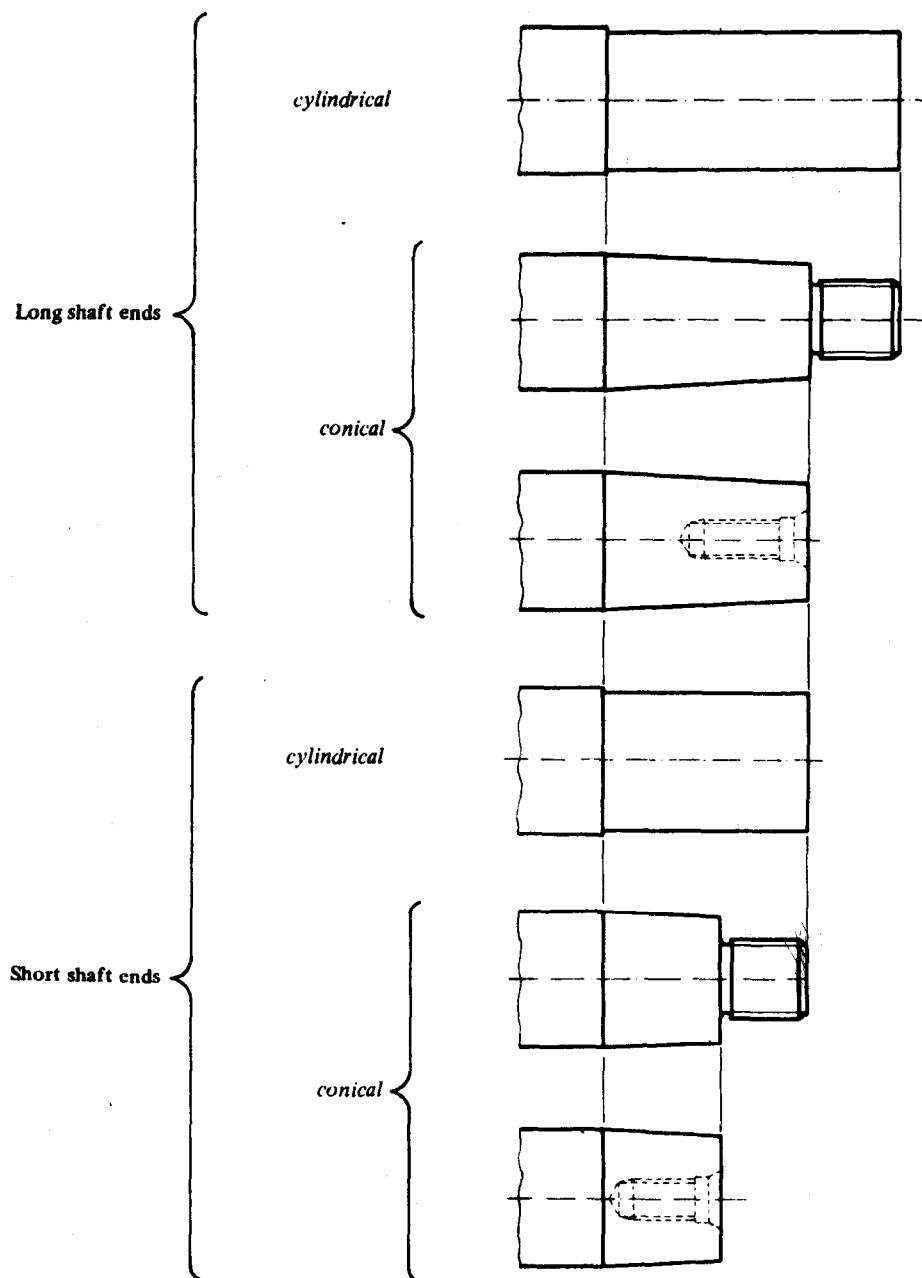
(1) Details of the internal thread will be specified later.

## ANNEX

### PRINCIPLES ESTABLISHING THE STANDARDIZATION OF CYLINDRICAL AND 1/10 CONICAL LONG AND SHORT SHAFT ENDS

#### Relationship between forms

The relationship between the various forms of shaft ends, cylindrical and conical, is shown below. This length relationship is generally valid, the exceptions being indicated in the tables in clauses 2.1 and 3.1.1.



## **ADDENDUM 1 : CHECKING OF THE DEPTH OF KEYWAYS IN CONICAL SHAFT ENDS**

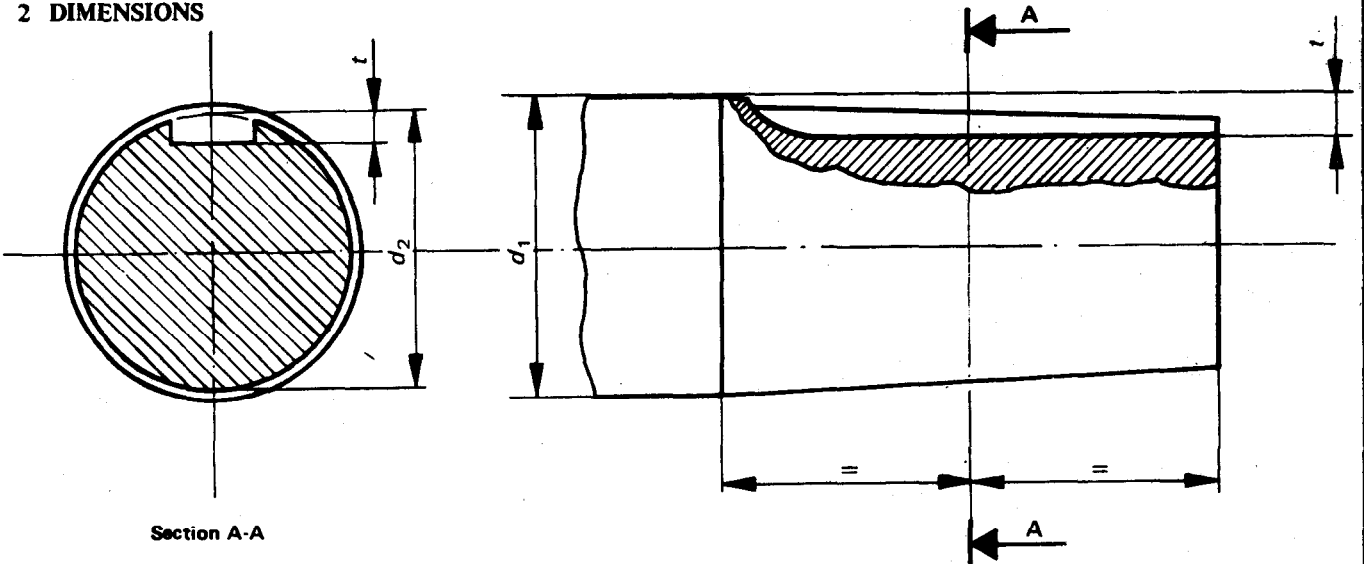
### **1 SCOPE AND FIELD OF APPLICATION**

This Addendum forms a supplement to sub-clauses 3.1.1 and 3.2 of ISO/R 775.

The table overleaf gives values for the checking of the depth  $t_1$  of keyways when it is desired to measure this from the nominal diameter of the shaft end.

The values of  $t$  given in ISO/R 775 remain the reference dimensions.

2 DIMENSIONS



$$t_1 = \frac{d_1 - d_2}{2} + t$$

Dimensions in millimetres

Diameter of shaft end $d_1$	Keyway depth $t_1$	
	Long shaft end	Short shaft end
11	1,6	—
12	1,7	—
14	2,3	—
16	2,5	2,2
18	3,2	2,9
19	3,2	2,9
20	3,4	3,1
22	3,4	3,1
24	3,9	3,6
25	4,1	3,6
28	4,1	3,6
30	4,5	3,9
32	5,0	4,4
35	5,0	4,4
38	5,0	4,4
40	7,1	6,4
42	7,1	6,4
45	7,1	6,4
48	7,1	6,4
50	7,1	6,4
55	7,6	6,9
56	7,6	6,9
60	8,6	7,8

Diameter of shaft end $d_1$	Keyway depth $t_1$	
	Long shaft end	Short shaft end
63	8,6	7,8
65	8,6	7,8
70	9,6	8,8
71	9,6	8,8
75	9,6	8,8
80	10,8	9,8
85	10,8	9,8
90	12,3	11,3
95	12,3	11,3
100	13,1	12,0
110	13,1	12,0
120	14,1	13,0
125	14,1	13,0
130	15,0	13,8
140	16,0	14,8
150	16,0	14,8
160	18,0	16,5
170	18,0	16,5
180	19,0	17,5
190	20,0	18,3
200	20,0	18,3
220	22,0	20,3

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